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Autonomous Vehicles Panel

2011 Pacific Operations Science & Technology Conference

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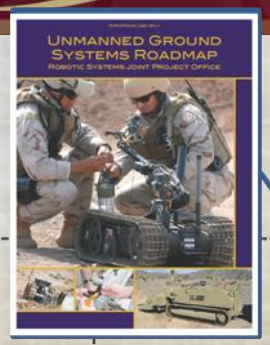
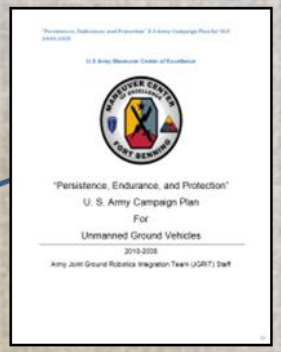
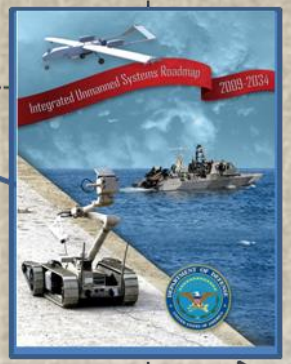
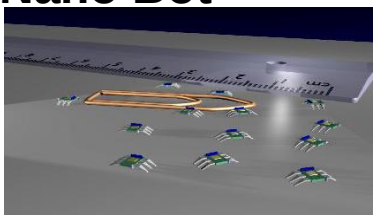
The Road to Requirements







Ground Robotics Capability Sets
(photos are notional representations)

Soldier Transportable	Vehicle Transportable	Self Transportable	Appliqué
Crew Served Bot 	**Mounted or Towed** Man Transportable Robot System (MTRS) POR 	**Soldier Follower IBCT**  Squad Multi-purpose Equipment Transport (SMET) CDD	**Remote Operation**  Husky Mounted Detection System (HMDS) POR
Small Bot Small Unmanned Ground Vehicle (SUGV) CDD 	 M160 Light Flail POR	**Medium Wingman SBCT**  Multi-Mission Unmanned Ground Vehicle (MM-UGV) CDD	**Supervised Autonomy**  Autonomous Mobility Appliqué System (AMAS) CDD
Micro Bot  CPD To be released	**Armed** 	**Heavy Wingman HBCT** 	**Full Autonomy** 
Nano Bot 	**Humanoid**  Battlefield Extraction Assist Robot (BEAR) Initiative	**Squad Member**  	**Exoskeleton** Exoskeleton (XOS) CDD 

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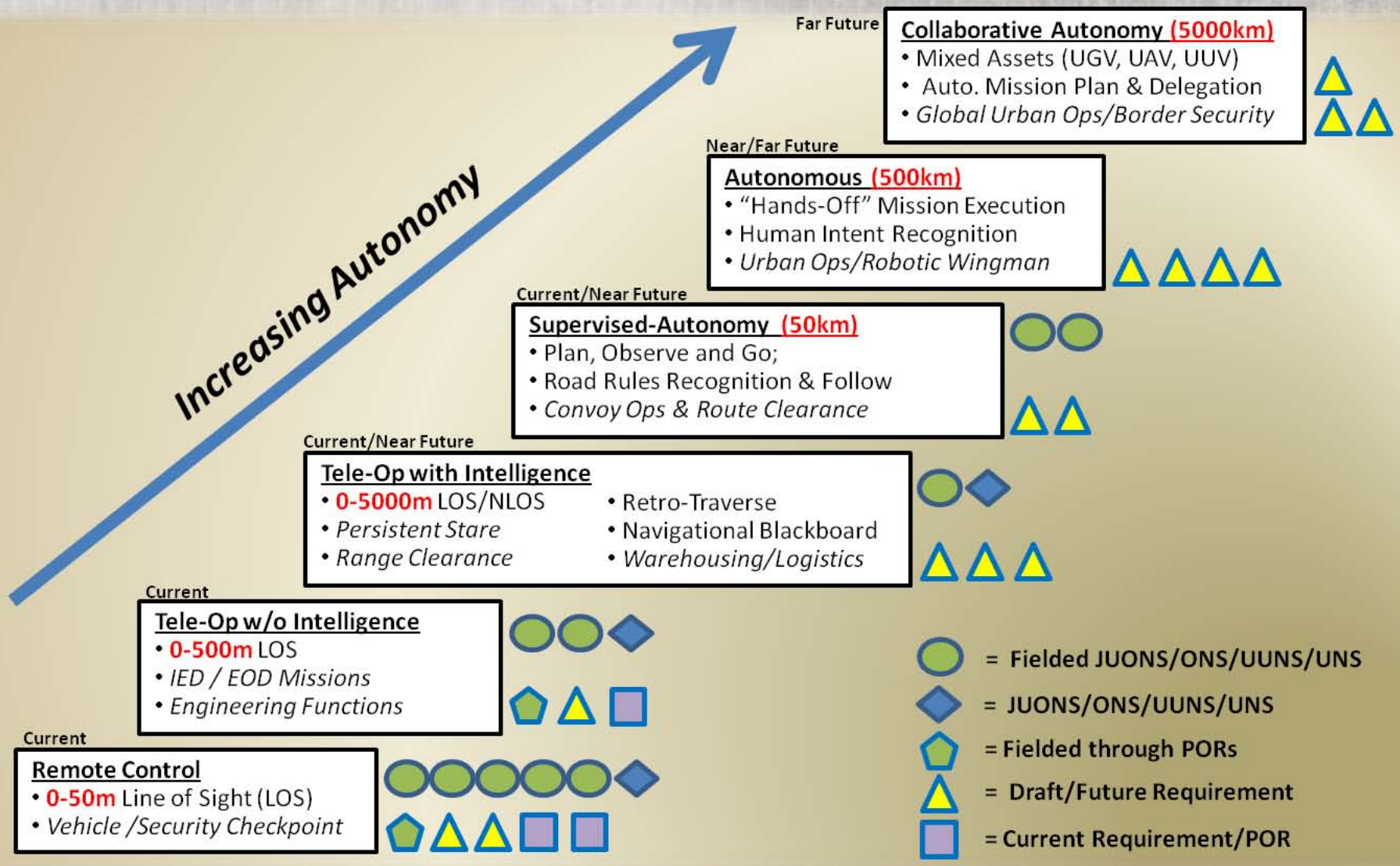
Current State of Ground Robotics



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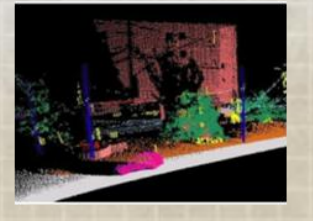
Ongoing Robotics Efforts
How the Army will keep it's Technology Edge

MAST CTA
Basic Research for Micro-systems
BAE, JPL, Michigan, Penn, Maryland, GA Tech, UC Berkeley, MIT

- *Autonomous operation of a collaborative ensemble of multi-functional, mobile micro-systems*
- *Micro-mechanics*
- *Micro-electronics*
- *Processing for autonomy*
- *Integration of multi-functional component technologies*


Near-term Quad-rotor

Robotics CTA
Fundamental Robotics Research
GDRS ,CMU , UPENN, Qinetiq , UCF, Boston Dynamics, FAMU



- *Fundamental technology to enable teaming of "intelligent "unmanned systems with soldiers*
- *Perception*
- *Planning, learning, & adaptation to dynamic, unknown environments*
- *Human-robot interaction*
- *Dexterous manipulation & unique mobility*


CAMS JCTD vehicle

MAGIC
International Robotics Challenge
U of MI, U of PA, Robotics Research

- *Harvest "Best-in-class" technology for teaming of autonomous SUGVs*
- *Many robots/few operators*
- *Autonomous mobility*
- *Planning for dynamic environments*
- *Minimize required soldier interaction*
- *Tactical behaviors*
- *Heterogeneous teaming*


Team RASR's modified TALONs

RDP's
Research & Demonstration Projects Conducted by RDECOM & other Army Organizations

- *Focused Research and Advanced Development programs directed at maturation and demonstration of new technical capabilities*
- *Safe Operations of Unmanned Systems in Complex Environments (SOURCE)*
- *Improved Mobility and Operational Performance through Autonomous Technologies (IMOPAT)*


TARDEC APD Testbed Platform

Robotics Rodeo
Industry S&T Market-Survey
iRobot, Oshkosh, John Deeere

- *Open solicitation for developers to bring systems for assessment by both soldiers and technologists*
- *Structured assessments in relevant environments and exposition of broad swath of available technology*
- *Opportunity to include new & novel technology into Army Acquisition*


GUSS vehicle

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Discussion and Way Ahead

Robotics are *enablers* and catching on but, mainly as *force multipliers* – Not yet replacing *force structure*

Some Challenges:

Cultural

- An unwillingness to reduce force structure.
- Trust and confidence issues related to autonomous behaviors (safety)
- Appreciation of the potential return on a robotic investment.

Moral

- Responsibilities associated with the Unmanned application of force

Social

- The incurious nature (lack of curiosity in a machine).
- Lack of comfort for people to operate in close proximity to machines.

- Move beyond ONS/JUONS capability gaps
- Develop a Robotic Environment (Test Bed or Base Ops)
- Leverage modeling and simulation for comprehensive DOTMLPF impact
- Conduct Independent Robotics Efficiencies Study to:

1) Determine return on investment for tasks robotics could perform (like robotic convoying)

2) Confirm that at various places along Bloom's taxonomy or some combination of dull, dirty, or dangerous tasks, we can replace humans.

3) Determine personnel life-cycle cost savings

4) Expose the user and the military community to semi-autonomous robotics through test bed, base and installations operations

MAGIC 2010 Partners

MAGIC 2010 DOWN UNDER
Multi Autonomous Ground-robotic International Challenge

"The U.S. and Australian Departments of Defense jointly sponsored MAGIC 2010 to attract innovative proposals from worldwide research organizations to develop heterogeneous teams of ground robots that operate autonomously with a minimum number of users that can be deployed effectively in military operations and civilian emergency situations."

- taken from MAGIC2010 Website

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TARDEC

Australian Government
Department of Defence
Defence Science and Technology Organisation

AMRDEC STRENGTH THROUGH TECHNOLOGY

Joint Ground Robotics Enterprise

Department of the Army United States of America 1775

U.S. Pacific Command

CERDEC

NIST

ARL

DARPA

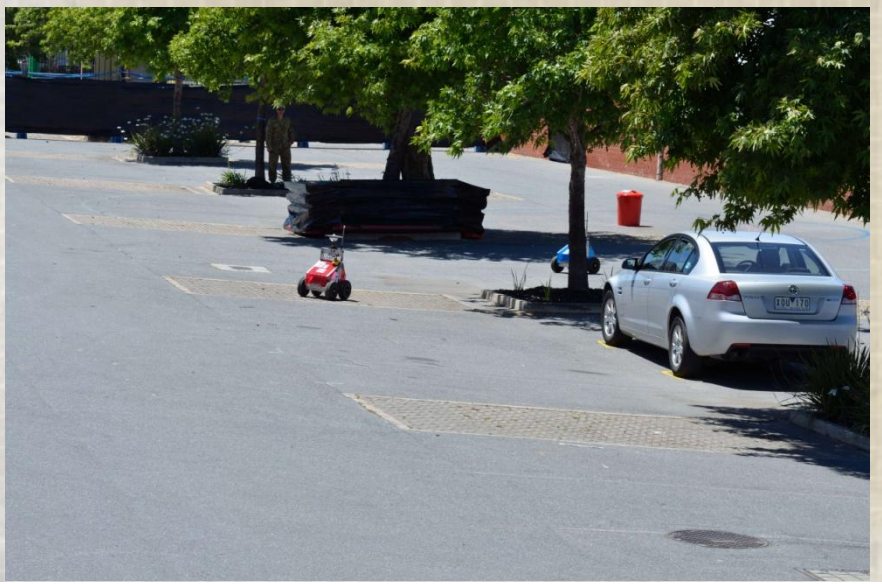
South Australian Mounted Rifles

Air Force Research Laboratory

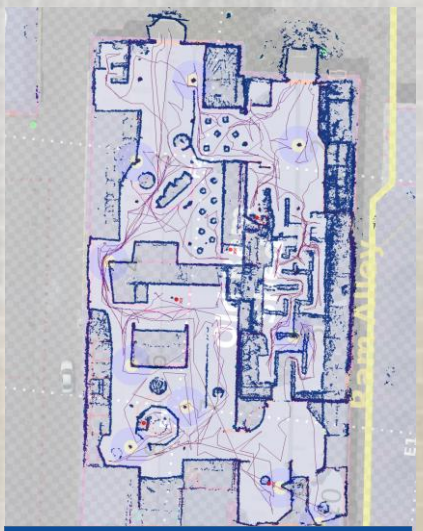
MAGIC 2010 Overview

Technology Challenges

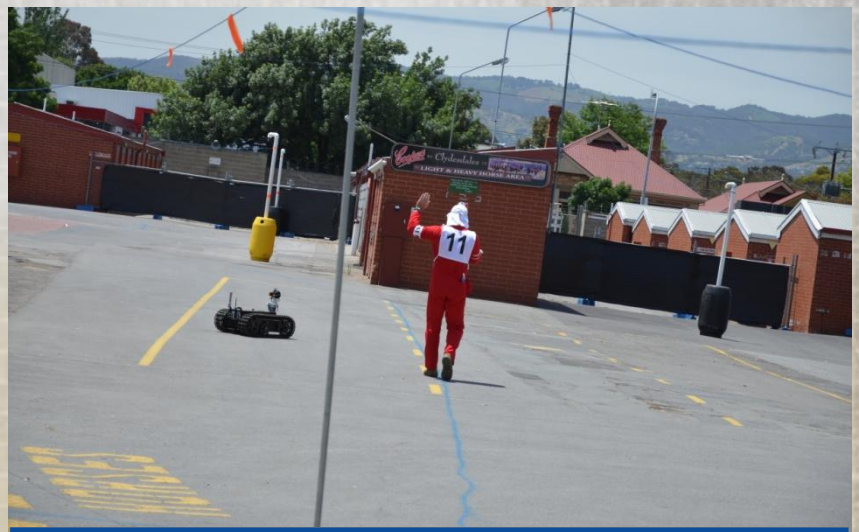
1. Flip the ratio of controllers to robots, i.e. less operators; more robots
2. Imbed individual and group 'behaviors' in teams of heterogeneous mobile platforms
3. Coordinate all assets in a bandwidth-limited urban environment
4. Show dynamic allocation and re-planning of robot resources under 'loss of robot' scenarios



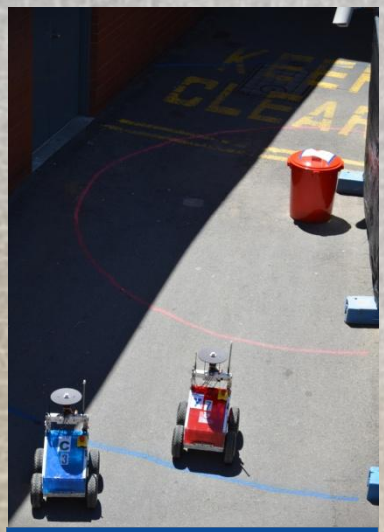
Tasks



Mapping



Identifying



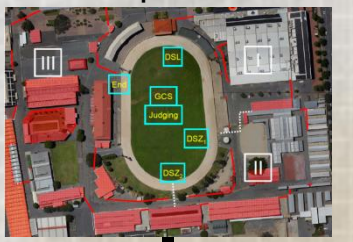
Neutralizing

≤ 2 Operators
≥3 Robots

3.5 Hours to Compete

Concept of Operations

apriori
map data



simulated UAV feed

robot operators

sensors

disruptors

'triggered' robot behaviors

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MAGIC 2010 Finalists

"Cappadocia" – Ankara, Turkey

- Comprising ASELSAN (Turkish military electronics company) with Bilkent University, Bogazici University, Middle East Technical University from Turkey, and Ohio State University (Control & Intelligent Transportation Research Lab) of the USA.

"Magician" – Perth, Australia

- University of Western Australia (Robotics and Automation Laboratory, Adaptive Systems Research Group), Flinders University (Artificial Intelligence and Intelligent Systems Laboratories), Edith Cowan University (Artificial Intelligence and Software Engineering Cluster), Thales Australia (D3S&A, Naval Division), ILLIARC Pty Ltd.

"RASR" – Gaithersburg, MD

- Reconnaissance and Autonomy for Small Robots Team - USA (Lead: Robotic Research, LLC; with Industry Partners: General Dynamics Robotic Systems, QinetiQ-NA, Del Services, Cedar Creek Defense, Carnegie Mellon Robotics Institute, Embry-Riddle Aeronautical University, University of Michigan.

"Team Michigan" – Ann Arbor, MI

- Comprising Soar-Tech with research support from the University of Michigan.

"University of Pennsylvania" – Philadelphia, PA

- BAE Systems as auxiliary team members.

1st Place/$750K - Team Michigan

2nd Place/$250K - University of Pennsylvania

3rd Place/$100K - RASR

The winners of the competition were announced at the Land Warfare Conference in Brisbane, Australia on 17 November 2010

3 Major Innovations

- Stripped down TALON IV platform with RSTA head and weighing under 40 Kg
  - RASR

- Low cost omni-directional camera and software for 360 SA
  - UPENN

- Michigan 3D bar-code for localization
  - Team Michigan

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